rhinum majus, making a hole at the bottom of the corolla of the flower near the stalk, and so getting at the honey from the outside. It was too late in the season to be able to observe it much, or often, but we are pleased to find others have seen it too.

In Sir John Lubbock's lecture at the London Institution he said some "humble-bees sucked the honey of the French bean and scarlet-runner in the legitimate manner, while other bees cut a hole in the tube, and so reached it surreptitiously."

This flower I speak of is one with the corolla much more marked than those the lecturer quoted. Next season we will hope to watch it again, and see if it only happens late in the year, for the injured blossoms seemed to wither very soon after the incision was made. MARY J. PLARR

Tunbridge, Jan. 9

Iron Pyrites.—Curious Phenomenon

SOME iron pyrites exhibited in a particular case in the Maidstone Museum have crumbled into a coarse, finely-divided mass. The specimens have been exhibited for about two months, and the decomposition has been effected in that time. Some other specimens recently removed from another case are becoming soft.

Could any of your readers account for this, and has such a thing ever been observed before? FREDERIC CASE

Maidstone, Jan. 19

OUR ASTRONOMICAL COLUMN

ANTARES AS A DOUBLE STAR.—The small bluish companion of Antares was detected by Mitchel at the Observatory of Cincinnati in July 1845. Measures taken by him in the summer of 1846 are published in No. 4 of his *Sidereal Messenger*. They gave the distance 2″·52, the companion preceding on the parallel, at the epoch 1846·59, and Mitchel thought this distance was half a second greater than at the time he discovered the small star. He mentions that on the 13th of August, 1846, he saw the star distinctly at 5.30 P.M., "the sun shining, unobstructed by clouds or mist." Early in the year 1848, Antares was repeatedly measured by Bond with the great refractor of Harvard College, and by Dawes in this country. Their mean result, weighted according to the number of nights, is—

1848·24 : Position ... 273°·71. Distance ... 3″·574.

The proper motion of the large star, though small, is still sufficiently sensible. Leverrier (*Annales*, tome ii.) assigns for the secular motion, – 0s·059 in Right Ascension, and – 3″·36 in Declination. If the above angle and distance are brought up to the present time with these values, we find on the assumption of merely optical proximity of the companion—

1875·25 : Position ... 288°·8. Distance ... 3″·54.

We would suggest that the star should be carefully re-measured, now that it is drawing away from the sun's place in the morning sky, to decide on the optical or physical connection of the components. Dawes' last measures in 1864 certainly rather favour the latter view, but they were made on a single night, and the object is one of difficult observation. It will be seen that on the assumption of optical duplicity, the distance is just now very nearly stationary, but the change of angle during the last twenty-five years amounts to 15 degrees, and will be easily confirmed or otherwise.

THE "TEMPORARY STARS" OF TYCHO BRAHE AND KEPLER.—The position of the famous star of 1572 in the constellation Cassiopea, with which Tycho's name is usually associated, has been determined with all the precision that his observations admit of, by Prof. Argelander, of Bonn. His place, reducing to the commencement of the present year, is in

Right Ascension	...	...	0h. 17m. 52s·6
North Declination	...	...	63° 27′ 18″.

Near to this position is a star of about the eleventh magnitude, which, by micrometrical comparison with two of its neighbours meridionally fixed, is found to have for the same epoch,

Right Ascension	...	...	0h. 17m. 52s·1.
North Declination	...	...	63° 26′ 24″.

It is, therefore, distant less than one minute of arc from the most reliable position of Tycho's star that can now be assigned. On this account alone it would be worthy of attention, but we are able to state, further, that during the last four years this small star has exhibited slight fluctuations of brightness at irregular intervals, which increases the probability of its identity with the star of 1572. It may also be noted that in August 1874 there was a decided ruddiness in its light.

Kepler's observations of the star which suddenly assumed such extraordinary brilliancy in the constellation Ophiuchus in the autumn of 1604, are contained in his work "De Stellâ novâ in pede Serpentarii," but the best position we possess is doubtless that deduced by Prof. Schönfeld of Manheim, from the observations of David Fabricius. For the commencement of the present year we have

Right Ascension	...	...	17h. 23m. 8s.·9
South Declination	...	...	21° 22′ 16″.

This position is probably liable to greater error than in the case of Tycho's star.

The nearest object at the present time is a star of the twelfth magnitude (or rather fainter), following the above place 6s·5 and 2½′ south of it, which has not sensibly varied during the last few years, but it is a suspicious circumstance that Chacornac has entered upon his chart No. 52, a tenth magnitude about 8s. preceding Schönfeld's place, and nearly on the parallel of declination, which is not now visible, or was not last summer. The neighbourhood requires to be closely watched. The observer may set the circles of his equatoreal for Oeltzen 16872, R.A. 17h. 23m. 34s., N.P.D. 111° 23′. The observations for Chacornac's chart were made between the 31st of May and 12th of August, 1861.

THE ZODIACAL LIGHT.—On the evening of Sunday last, the 24th inst., a surprisingly bright display of this as yet problematical phenomenon was exhibited. There was a repetition on the following evening, but in a less favourable sky. The light had the usual yellowish or pale lemon tinge of the more notable exhibitions in these latitudes. The axis of the light appeared to pass λ Piscium, and the vaguely-defined apex was situate somewhere about 19 Arietis, but it was not possible to locate it with anything like precision. The light was broad and of a deeper, perhaps, ruddy tint near the horizon. The display to which we have adverted, excelled in brightness any that has been witnessed in the neighbourhood of London for many years. It appears very probable that opportunities for favourable application of the spectroscope may be afforded in the dark evenings of the present and following months.

PLANETARY THEORIES *

THE theory of Neptune, which I have the honour of presenting to-day to the Academy, completes the *ensemble* of the fundamental theories of the planetary system, of which the first dates back to September 16, 1839, thirty-five years ago.

The numerous developments added year after year are all mentioned in the organ of the Academy. Some of them figure only by their titles, and as they are scattered through a great number of volumes, the Academy will no doubt permit me, at the moment when I have arrived at the end of this long discussion, to present a precise but succinct *résumé* of them.

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* "New Theory of the Motion of the Planet Neptune; with Remarks on the *ensemble* of the Theories of the eight principal Planets, Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, and Neptune." A paper read before the French Academy of Sciences by M. Leverrier, December 21, 1874.

In 1849, after I had already been engaged for ten years in the work, and the better able to estimate the difficulties, I presented its essential conditions in terms in which I have no alteration to make.

None of the tables, let us say, intended to represent the movements of the planets, accord rigorously with the observations. The most precise, those of the Earth and Mercury, are not so accurate as could be wished. I do not speak of those irregular discrepancies which the uncertainty inseparable from every physical measurement necessarily introduces between observation and calculation, but rather of those systematic errors whose variation follows a determined law, the real existence and regularity of which are prominent in the *ensemble* of the work of the different observatories, and for which theory alone can be blamed. These inaccuracies ought to engage our earnest attention; no doubt they are inconsiderable, but, on the other hand, they are everywhere present, and their smallness does not authorise us to neglect them.

It would assuredly not be very serious in itself that our astronomical tables should make an error of half a second in the time of the passage of a star on the meridian, if the importance of this error did not lie in its degree of certainty rather than in its magnitude. Every discrepancy betrays an unknown cause, and may become the source of a discovery. If these errors should increase considerably with the time, we may, it is true, await their complete development in order to read with greater certainty, in their onward progress, the cause which produces them; but, first, we should thus leave to posterity the task of perfecting science and the advantage of discovering new truths. Moreover, certain extraneous influences may manifest themselves by effects always slightly sensible; and if we neglect these effects, the cause on which they depend will remain for ever unknown.

The theory of the motion of a planet rests upon the hypothesis that each planet is subject only to the actions of the sun and of the other planets, and, moreover, that these actions are exercised conformably to the principles of universal gravitation.

But the consequences of the Newtonian law have not been, in many respects, deduced with sufficient rigour; and, on this account, we are not in a condition to decide if the disagreements evident between observation and calculation are due solely to analytical errors, or rather if they are partly due to the imperfection of our knowledge of celestial physics.

It will be necessary, then, to take up again the mechanical theories of the motions of the planets, and to rigidly examine them to their most remote consequences, before we are able to effect a decisive comparison with observations. This is what has been done.

Let us rapidly state that the general developments have been the subject of five memoirs, presented and published in 1840, 1843, 1849, and 1855.

The formulæ relative to secular irregularities have been treated particularly in the memoirs of 1840 and 1841.

The same subject has been handled, in a more general and more complete manner, in the paper communicated to the Academy on Nov. 11, 1872, concerning the four great planets, Jupiter, Saturn, Uranus, and Neptune.

The theory of Mercury, presented in 1843, since completely revised, was only definitely completed in 1859.

The theory of Venus was given in 1861.

That of the Sun (the Earth) in 1853 and 1858.

That of Mars in 1861.

The theory of Jupiter in 1872 and 1873.

That of Saturn in 1872 and 1873.

The theory of Uranus, given in 1846, and connected with the discovery of Neptune, was the subject of a new work presented on Nov. 15 last.

Finally, the last theory, that of Neptune, is offered by us to the Academy to-day.

The theories of Jupiter, Saturn, Uranus, and Neptune have the peculiarity that they are developed in functions of indeterminates, so that their use may be prolonged during an unlimited time.

The theories once established, it will be necessary to compare them with the long and valuable series of meridian observations devised by Rœmer, instituted for the first time at Greenwich, in September 1750, by the famous observer Bradley, and continued since then to our own days in the great observatories. But as the positions of the moving stars are connected with the fixed stars, it is evident that it will be necessary also to be assured of the relations of the stars among themselves, with respect to the equinox and the ecliptic. This necessity is particularly imposed in respect to right ascensions, on which specially depends a knowledge of the motions of the planets. The work was effected in the memoir of April 5, 1854, for the series of observations of Bradley. This was a delicate subject, for it necessitated the revision of the labours of Bessel, given in his work entitled "Fundamenta Astronomiæ." We have had to propose various corrections in the positions of the fundamental stars, and the verification of the accuracy of these corrections was put to the test (*au concours*) in Germany. The result confirmed all our determinations. Consequently they have served us in establishing with certainty the positions of the stars of comparison during the 120 years of observations which we have had to consider.

The comparison of the motions of Mercury with the theory given by us in 1843 did not present from the first a satisfactory result. The transits of Mercury across the Sun furnish data of very great precision, but which it was not possible completely to satisfy.

This first result fills us with uneasiness, it is known. May not some error in the theory have escaped our notice? New researches, in which everything was tested in various ways, only tend to convince us that the theory was accurate, but that it did not agree with the observations. Years passed, and it was only in 1859 that we managed to discover the cause of the established anomalies. We discovered that they are all connected with a very simple law, and that it is sufficient to increase the motion of the perihelion by 30½ seconds per century to reduce everything to order.

The displacement of the perihelion acquires thus in the planetary theories an exceptional importance. It is the surest indication, when it must be increased, of the existence of a cosmical matter yet unknown, and circulating like other bodies around the Sun. It matters not whether this matter may be agglomerated into a single mass, or disseminated in a multitude of meteorites independent of each other. Provided that its parts all circulate in the same direction, these effects combine to impress upon the perihelion a direct motion.

The consequence is clear. There exists in the neighbourhood of Mercury, between the planet and the Sun, without doubt, a matter, a material hitherto unknown. Does it consist of one or more small planets, or of meteorites, or even of cosmical dust? The theory does not pronounce on this point. On many occasions, trustworthy observers have declared that they observed signs of the passage of a small planet across the Sun; but nothing definite has been reached on this subject.

We should not, however, doubt the accuracy of the conclusion. We shall see, in fact, the same analysis applied to the discussion of the observations of Mars lead to an analogous result, and this result found fully verified.

Bessel has said of the theory of the sun that it has not made the progress we should have expected from the great number and the value of the observations. This estimate has for long troubled our mind, too trustful of this supposed accuracy of the observations. After having revised and discussed anew the observations of the Sun, made since the time of Bradley at Greenwich, at Paris, at Königsberg, to the number of 9,000, we have been forced to quite a different conclusion, viz., that the observations of the Sun are far from what they ought to be, on account of the systematic errors which affect them, and that there is no discordance between theory and observation which may not be attributed to errors in the latter.

In spite of all, the discussion of the observations of the Sun led us hence to an important result connected with the great question which agitates, at this moment, the scientific world; a result which surprised ourselves, so much had the determination of the parallax of the Sun, deduced by the director of the Berlin Observatory from the Transits of Venus in 1761 and 1769, inspired a false confidence. I arrived at the conclusion that the parallax of the Sun, estimated then at 8·57″, ought to be increased by the 25th part of its value.

Soon after, the comparison of the theory of Venus with the observations led to the same result, the necessity of increasing by $\frac{1}{25}$ the parallax of the Sun.

Finally, the theory of Mars led, in its turn, to a conclusion not less precise. It was proved that we could not account for the *ensemble* of the observations of Mars without increasing the movement of the perihelion by about one-eighth. This was the reproduction of the same fact as in the case of Mercury, and the conclusion to be drawn from it was the same, viz., that the planet Mars must be subject to the action of a quantity of matter till then neglected, and that it must be estimated at the eighth part of the mass of the Earth.

But then two hypotheses were possible, as we explained at the *séance* of June 3, 1861: either that the matter till then left out of the count resided in the belt of the small planets as a whole, or that it must be added to the Earth itself. In the latter case, and as a consequence, the parallax of the Sun must be increased by the 24th part of its received value, that is to say, that we would be led to the same result already deduced from the theories of the Sun and of Venus.

Meantime M. Fizeau has given a method for determining the speed of light, by a physical experiment, on the surface of the earth; and from this measurement, combined with the quantity of the aberration of the stars, we know that we can deduce the parallax of the Sun.

Foucault, on his part, had devised a plan of solving the same question by another method, and he was engaged in realising the experiment. I pressed him strongly to carry it into execution. We know that in the *séance* of Sept. 22, 1862, Foucault announced that he had fixed the rate of light at 298,000 kilometres per second; hence, by adopting the quantity of aberration determined by Struve, 8·86″ resulted for the parallax of the Sun, a number corresponding to an increase of 1-30th of the received value.

M. Cornu, in the important paper read by him at the last sitting, resolved definitively the question by the employment of the method of M. Fizeau. He was good enough to refer to the determination which I presented to the Academy at the sitting of July 22, 1872, based on the celebrated and very exact observation of the occultation of the star ψ^2 Aquarii by the planet Mars, an occultation observed in 1672 by the three great astronomers, Richer, Picard, and Rœmer.

Moreover, we shall combine materials obtained from various points of view on this delicate question, and will further increase by discussion the great interest which will be presented by the materials collected with so much devotion by the various expeditions destined to the observation of the present Transit of Venus. For this reason, and because the method which results from the occultation of ψ^2 Aquarii is present under a form precise and striking, we shall shortly ask permission from the Academy to deposit the work in its hands, after having given it the necessary developments.

Jupiter and Saturn have given rise to a theoretic work the extent of which has been considerable, on account of the very great mutual perturbations of the two planets. The comparison of the theory of Jupiter with the observations has presented, after the proper modifications of the elements, a complete harmony. The tables of Jupiter have also been adopted by the editor of the *Nautical Almanac* to serve for the preparation of that important work. I owe to our *confrère* Mr. Hind, superintendent of the *Nautical Almanac*, the satisfaction of thus seeing adopted by the astronomical world the various tables of Mercury, the Sun, Venus, Mars, and Jupiter, so far as they have appeared.

The tables of Saturn are now constructed, and their comparison with the observations is almost finished.

The theories of Uranus and of Neptune being also completed, it only remains further to effect their comparison with the observations.

The profound knowledge which my excellent colleague M. Gaillot, chief of the Bureau des Calculs, and member of the Council of the Observatory, has of these matters, and the devotion with which he has assured the laborious construction and comparison of the tables of Jupiter and Saturn, are to me a sure guarantee that the final work will be, whatever happens, carried out to the end.

RUSSIAN FORESTS

VEGETATION in the fossil or recent state forms the main source of the wealth and prosperity of most nations, either directly or indirectly: directly, in the case of the vast subterranean deposits of the remains of former plant-life in Britain, as also in the broad expanses of land covered with timber-trees in Russia. According to recent statistics* the extent of the forests of Russia in Europe is about 442,897,500 acres, or forty per cent. of the whole area. The forests are very unequally distributed, and internal communication is still very imperfect in many parts of the empire; hence much of this wealth is at present unavailable. Every year, however, the facilities for transport are increased, and there is a corresponding augmentation in the amount realised. Nearly sixty-five per cent. of the forest land is situate in the four governments of the North—Archangel, Vologda, Olonetz, and Perm; this equals sixty-five acres to each inhabitant. The governments of the South are relatively poor in timber, and in some parts almost treeless; but since 1842 the forest administration has been engaged in remedying this defect by planting largely. Between 1866 and 1870 upwards of 20,000 acres were planted, exclusive of the action of private owners. The principal trees are the Scotch pine, spruce fir, larch, birch, lime, aspen, and oak. To these may be added for the governments of the South, though relatively playing an unimportant part in commerce, the elm, ash, beech, hornbeam, maple, various poplars and willows, &c. The value of the forest products exported in 1871 amounted to 16,026,553 roubles, of which more than one-third came to this country. But the internal consumption gives a better idea of the immense wealth of these forests. It is only possible to give an approximate estimate of the value, which Mr. Werekha states must be at the very least 265,450,000 roubles per annum. In Russia, wood is still either the only or the principal fuel used. The railways consume wood for fuel to the annual value of 7,200,000 roubles. Wooden drinking-vessels, platters and spoons, take the place of pottery and metal in many districts, except in the houses of the rich. Mr. Werekha estimates that forty million wooden spoons are made every year; but Mr. Weschniakoff, in his account of the domestic industries of Russia, puts the figure at thirty millions.

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* "Notice sur les Forêts et leurs Produits," etc. Par P. N. Werekha.